

4. CHARACTERIZATION METHODS

4.1 Existing Borehole Locations

Many boreholes have been installed at the Tank Farm for sampling, monitoring, and scientific purposes. Over time, some of these boreholes have been removed, damaged, or lost, and a complete inventory of borehole locations, depths, and construction characteristics is not available. Existing information shows that the majority of the boreholes were constructed using 5.08-cm (2-in.) inside diameter (ID) steel casing and were installed to depths ranging from 3.1 to 12.2 m (10 to 40 ft). The location of these boreholes is shown in Figure 4-1, as reconstructed from existing databases and historic documents. These existing boreholes (as many as 58) will be included in the downhole radiation logging program and are anticipated to be logged first. If sufficient information is collected from an existing borehole to satisfy the data need of a new probehole, then the new probehole will not be installed at that location.

4.2 Surface Radiation Mapping

Surface radiation mapping will be performed throughout the Tank Farm investigation area as a means to identify radioactive soil contamination within the upper 0.3 – 0.6 m (1-2 ft) of the Tank Farm subsurface. Figure 4-2 shows the planned locations of the probeholes. Measurements will be performed, using a large cart-mounted plastic scintillation detector or a hand-held sodium-iodide detector, as discussed in Section 5. Maximum required data spacing is on a 0.9 × 0.9 m (3 × 3 ft) grid with the detector positioned from 0 to 7.6 cm (0 to 3 in.) above the ground surface.

4.3 Predrilling Using Vacuum Excavator

The presence of buried pipes, valve boxes, and other infrastructure elements associated with past and present Tank Farm operations creates a substantial hazard for any invasive activities within the Tank Farm soil. If an infrastructure feature was struck by drilling or excavation equipment, a contaminant release could occur. Since the Tank Farm infrastructure occurs almost exclusively within the depth interval from 0 to 3.7 m (0 to 12 ft), probe and/or instrument installation through the upper soil zone will be accomplished using a vacuum excavation system to prevent damage to the infrastructure.

Vacuum extraction technology involves the use of a high-pressure jet of air, directed by a nozzle called an air lance, to penetrate, expand, and break up soil. Soil material, including rock and debris, is removed by a 4-in.-diameter vacuum hose to a drum or similar receptacle (anticipated to be 35- or 55 gal). This process is a closed loop system, thereby reducing the risk of an air release. Vacuum extraction advances the probehole without damaging underground pipelines or utilities.

The vacuum excavator will be used to excavate a pilot hole 7.6 to 12.7 cm (3 to 5 in.) in diameter to a depth of 4.6 m (15 ft) bgs. A schematic of the probehole installation is shown in Figure 4-3. If the vacuum excavator encounters subsurface piping or other infrastructure, the hole location will be abandoned in favor of a new location at a nearby position, unless the probehole casing can be placed safely adjacent to the obstacle. Soil will be excavated in 1.5-m (5-ft) increments (0 to 1.5 m [0 to 5 ft], 1.5 to 3 m [5 to 10 ft], 3 to 4.5 m [10 to 15 ft]) and stored temporarily in drums labeled according to hole position and depth. The drummed soil will be screened by field radiation monitors and sampled after all of the probeholes have been completed. Sample analysis for this soil is discussed in Section 6.

As the vacuum excavator will be using air to remove soil from the probehole, cross contamination between probeholes should not be significant relative to the nature of the measurements (downhole gamma-ray survey) being made in the completed probeholes. The amount of contamination that can be carried from the vacuum hose and air lance is negligible relative to the volume of soil being removed.

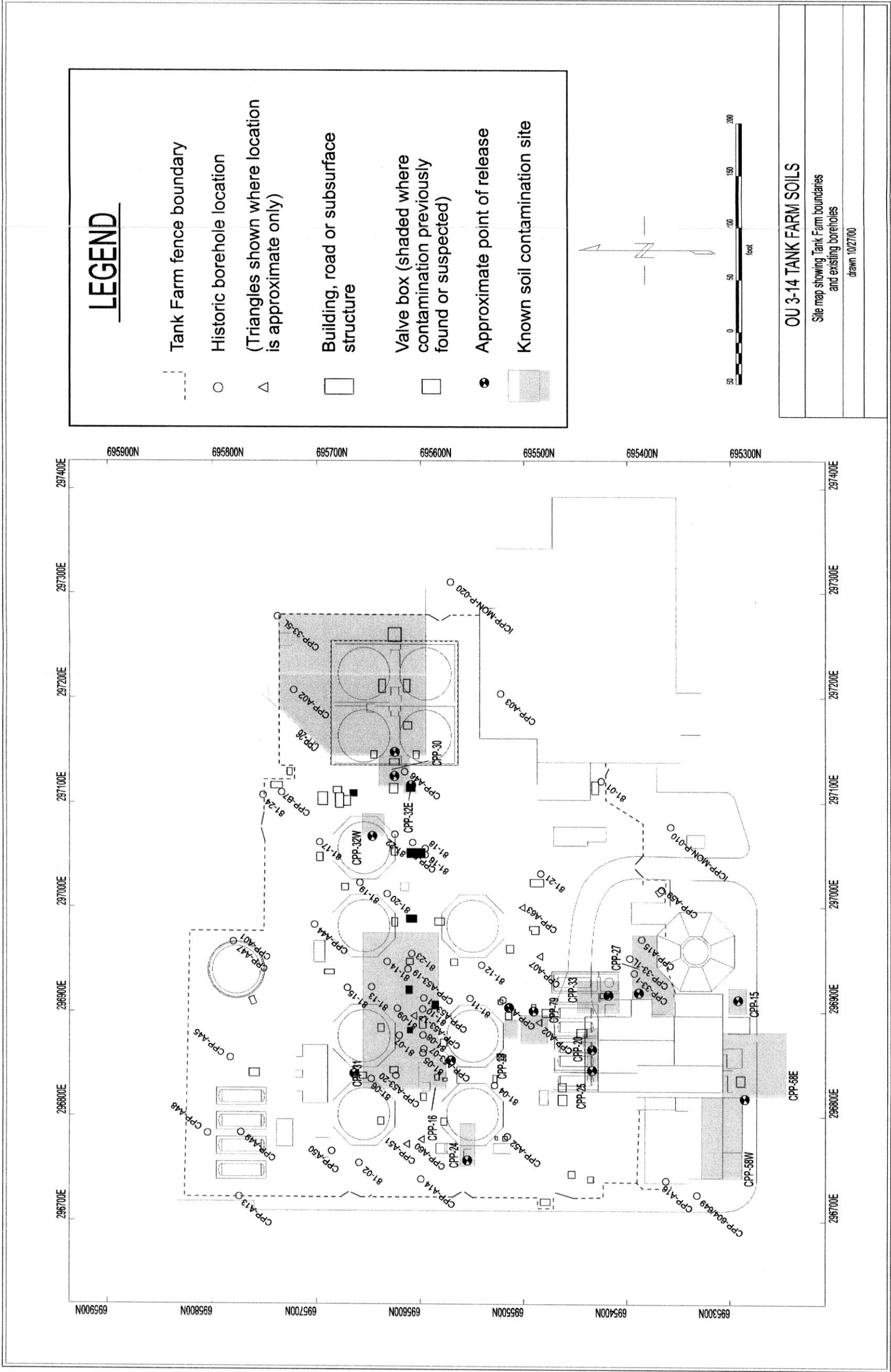


Figure 4-1. Locations of release sites and existing Tank Farm boreholes used in the first gamma survey.

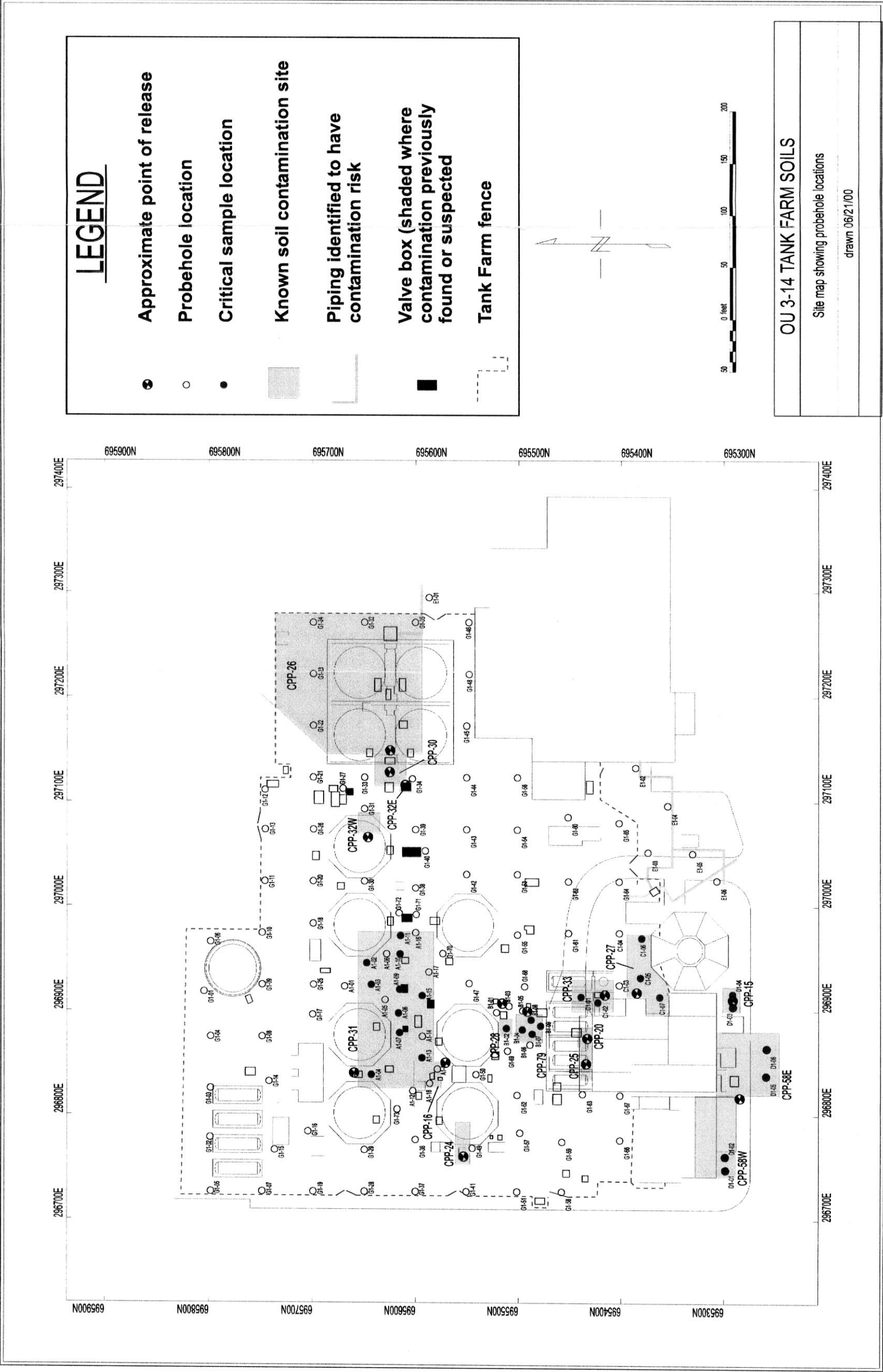


Figure 4-2. Map of planned probehole locations.

Moreover, the probehole investigation is planned to generally proceed from the least contaminated areas to the most contaminated areas. Cold test demonstration planning will address cross-contamination concerns and drum sampling technique. If extensive contamination is identified in the air lance and associated hosing, the contaminated equipment will be discarded and new equipment used. Determination methodology of the drummed soil that will be direct sampled is discussed in Section 4.6.

After successful completion of pilot holes using the vacuum excavator, the steel probehole casing will be installed to the bottom of the hole. Clean soil may be placed into the annulus between the casing and the probehole wall. This procedure will permit probehole casings to be installed with minimal void space around the probehole casing for a more accurate reading of that specific location. Probe construction techniques will be selected after the development of technical and functional requirements for this activity.

4.4 Direct Push Drilling in Tank Farm Soil

The probehole locating strategy was developed to provide full coverage of the Tank Farm soils and the release sites. The current strategy assumes that no existing probeholes could be utilized. The systematic gridded probehole pattern and location density were deemed sufficient to characterize the area within the Tank Farm fence line not associated with known releases. In addition, probeholes located outside of the normal grid pattern, east and southeast of the Tank Farm fence, were included because the piping they will attempt to characterize was identified by Tank Farm personnel as having transferred waste. These probeholes were included in the Phase I investigation for completeness, and not because the piping is expected to be leaking.

No effort was made to rank the transfer piping within the tank farm with respect to characterization priority. All transfer pipelines in the Tank Farm were assumed to have transferred waste material. The proposed probehole locations will be optimized with respect to existing probeholes, infrastructure, and known release sites. If an existing probe is viable for the purposes of this investigation, a new probe will not be installed in that location. If it becomes necessary to adjust probe locations, the Agencies will be notified by conference call. Any sample locations that were not characterized during this Phase I effort, but still considered fundamental to the study, will be carried forward to the Phase II work.

Several manufacturers produce a direct push system capable of installing a 2-1/2-in. diameter steel probe to a depth of approximately 14.5 m (50 ft), which is the anticipated average depth to basalt at the Tank Farm. These systems utilize a truck-mounted power unit or power-take-off unit to power the hydraulic push system. This system is coupled with a hydraulic hammer to assist in installation by pounding on the casing. This procedure is in compliance with the vibration limitations set forth in "Tank Farm Load Limitations" (Attachment C). This method will result in installation of the probehole casings without creating drill cuttings or drilling fluids to remove cuttings. This method will also allow for installation of the casings without the need for containment and excessive PPE requirements.

A direct push rig will be used in the Tank Farm to install the probehole casings for downhole radiation detection logging (gross gamma). The casings will already be installed from 0 to 4.5 m (0-15 ft) bgs during the vacuum extraction portion of the operation. The rig will back up to the pre-installed casing, attach, and then push/pound to depth. Steel casing will be attached in 1.2-m (4-ft) sections as the probehole is advanced. Upon reaching the basalt, or refusal, pushing/hammering will cease and the casing will be detached from the rig at the lowest possible position to maintain an aboveground completion. Exceptions may be made in specific areas determined by Tank Farm personnel, as some probeholes may be completed at ground surface. The casing will be capped with an all-weather cap to prevent entry of unwanted materials.

The direct push rig will be surveyed by the RCT, using a hand-held radiation detection monitor (Ludlum 2a or equivalent), and smears will be collected if deemed necessary by the RCT. If no contamination is detected, the rig will be moved to the next probehole location. If contamination is found, attempts to remove the contamination, using dry decontamination (or other decon methods stipulated by the RCT), will be performed. When the rig is connected to the next probehole casing, the installation procedure will be repeated.

If a casing cannot be completed to basalt, written documentation will be provided as to why moving the probehole location is necessary. If the revised location is laterally within ± 0.76 m (± 2.5 ft) of the initially proposed location, it will be considered acceptable. If the probehole cannot be completed in the revised location, an entry will be made in the logbook and serve as formal documentation. The Agencies will be subsequently notified. The casing will not be removed from the Tank Farm soil, due to the possible radiation exposure to workers and the environment. It will be capped and left in place.

Subsequent probehole locations may be identified, based on the downhole logging data results. Installation of those probeholes will be performed as a part of the Phase II effort.

4.4.1 Direct Push Probehole Installation

This FSP describes the installation of 120 cased probeholes to the surficial sediment/basalt interface, approximately 13.7 m (45 ft) bls (see Figure 4.2). Approximately 85 of the probeholes shall be installed in a grid pattern. Approximately 35 of the probeholes will be installed in the hot spots, which are located in sites CPP-31, -28/79, and -27/33. Probeholes shall be installed using a hydraulically powered, direct-push probing rig (e.g., AMS PowerProbe, Geoprobe, Stratoprobe) to advance a 5.4-cm (2-1/8-in.) ID hollow probehole casing 1.2-m [4-ft] sections) with a threaded drive point from the land surface to the sediment/basalt interface (see Figure 4-3). This will allow for in situ characterization of radiological contamination. Once the hollow 5.4-cm (2 1/8-in.) ID probehole casing has been advanced to the sediment/basalt interface or until refusal, the probing rig/vehicle will relocate to another probehole location. Final depths of each probehole will vary based on the depth of the sediment/basalt interface. Soil will be displaced laterally with the direct push monitoring probehole installation, thus eliminating accumulation of surface drill cuttings. The probeholes will be logged with an in situ (downhole) radionuclide assay system to detect gamma radiation.

In general terms, the installation of the probes will proceed as follows:

- After vacuum excavation to 4.6 m (15 ft) has been completed and no subsurface structures have been encountered, a 5.4 cm (2-1/8-in.) ID diameter probehole casing with a threaded drive point will be installed and direct-push advanced until the sediment/basalt interface is encountered. The threaded probehole casing will be advanced in 1.2-m (4-ft) sections. Real-time radiological field screening activities will be conducted as probing through the surface sediments occurs and readings with estimated depths will be recorded in the field notes.
- Once the probehole casing has been advanced to the final depth, the drill rig will move off the probe site. If required by the RCT, radioisotope smears of push probe equipment will be collected and analyzed prior to movement of the vehicle to the next location. Once the rig is approved as clean by the RCT, the rig will be set up at another probing location. All probehole casing threaded drive points will be left in place to allow access for downhole gamma radiation logging.

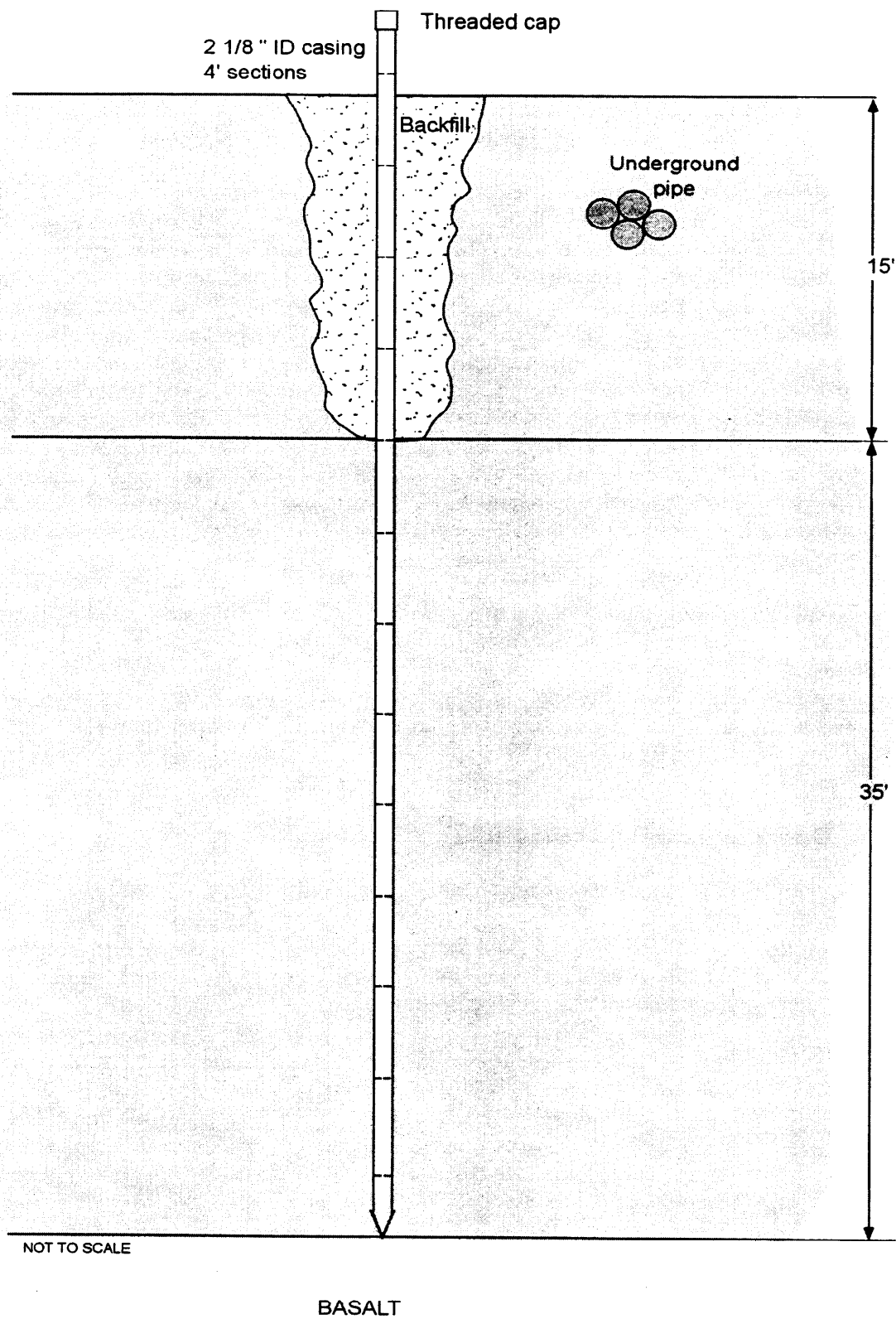


Figure 4-3. Schematic of probehole installation.

- The probehole shall be logged with an in situ radionuclide assay system to screen the surface sediments (the upper 5 m [15 ft]) for gamma radionuclide contaminants. If this logging does not provide useable data, it will be discontinued.

4.5 Downhole Radiation Logging

Downhole radiation logging will be performed in steel-cased probeholes installed on a modified 50-ft grid, encompassing the entire Tank Farm soil investigation area, as illustrated in Figure 4-2 to better characterize the sites. A closer spacing of probeholes was provided in known hot spot locations in larger release sites. Detailed views of these sites, along with the tanks, piping, and other structures, are provided in Figures 4-4, 4-5, and 4-6. Figure 4-4 provides a detailed map of Sites CPP-16 and CPP-31; Figure 4-5, provides a detailed map of Sites CPP-28 and CPP-79; and Figure 4-6 provides a detailed map of, Sites CPP-27 and CPP-33. Probeholes will be installed to basalt by the methods discussed in Section 4.4. The modified 50-ft grid is based on a symmetric 50-ft grid pattern with the addition and/or adjustment of some probehole locations to accommodate surface obstructions and to obtain sampling access in key locations, such as near valve boxes and known release sites. The primary 50-ft grid pattern is designed to investigate the entire Tank Farm soil area (CPP-96) for the presence of unknown contaminated soil zones. Additional probeholes are included to investigate high contamination risk locations, such as soil adjacent to valve boxes and/or concentrated piping that currently or previously handled radioactive waste streams. Subsurface logging is described in Section 5.

Downhole radiation logging measurements will be performed in the steel-cased probeholes from ground surface to total depth. Downhole radiation logging of the probes from the surface to 15-ft bgs will be performed for the first couple of probeholes. The results will be examined to determine if the information is representative of the soil contamination at that location. Evidence that the logging results are invalid due to the soil vacuuming, backfill soil around the casing, or other reason affecting the top 4.5 m (15 ft) will result in discontinuing the 0 to 4.5 m (0 to 15 ft) bgs logging of the remaining probeholes.

4.5.1 Downhole Logging Limitations

The principal limitations of the planned downhole logging program are as follows:

- The planned logging system will not have sufficient gamma-ray energy resolution for detailed radionuclide speciation. While gamma radiation hot spots can be detected, the causative radionuclides cannot be determined.
- The logging tool has a finite depth of investigation due to the fact that gamma rays are attenuated by the soil media and casing surrounding the probehole. For Cs-137, the depth of investigation is on the order of 1 ft from the center of the logging detector. This limitation is a significant problem primarily when the radionuclide distribution is highly discontinuous, since abrupt changes in concentration would not be detected if they occur just beyond the investigation zone. At the Tank Farm, it is reasonable to assume that radionuclides exist as broad soil plumes with concentrations that vary smoothly from a central hot spot to a background fringe. In this case, distributions may be accurately interpolated between probeholes. However, the exact location of the hot spot and fringe will be subject to uncertainty proportional to the probe spacing.
- Low energy gamma rays, e.g., from Am-241 or Pu-239, will be greatly attenuated by the probe casing. Thus, the presence of low-energy gamma emitters will generally not be recognized unless they are co-located with higher energy gamma

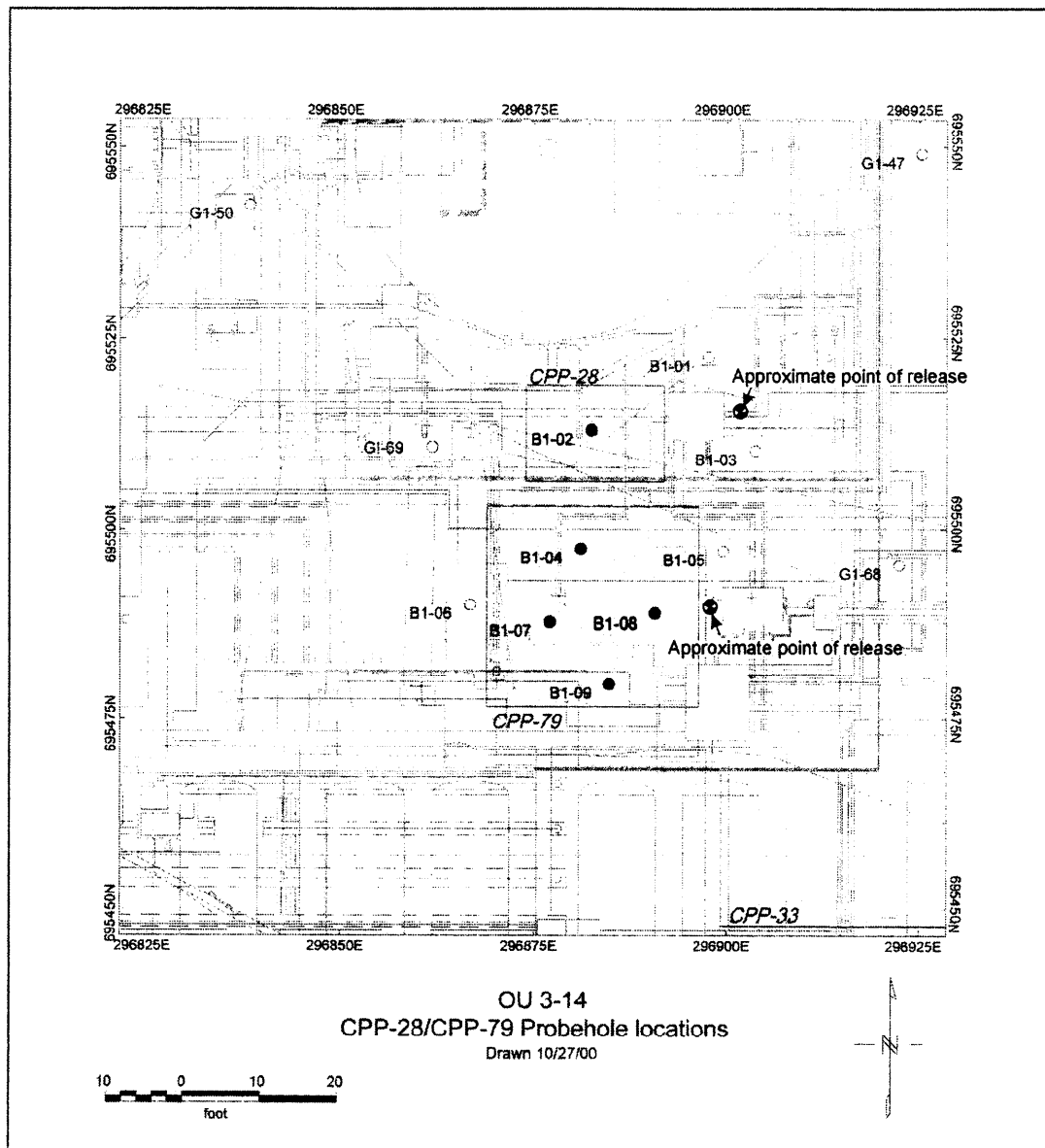


Figure 4-5. Detailed map of probe locations within Sites CPP-28 and CPP-79 (critical locations in red).